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# Assessing Agroforestry Adoption Potential Utilising Market Segmentation: A Case Study in Pennsylvania

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In the United States, agroforestry adoption has lagged behind progress in agroforestry systems research. This study sought to facilitate the communication of landowner land management objectives, values, knowledge and perceptions of the barriers and benefits to agroforestry through applied social marketing research methods and market segmentation analysis. A mail survey instrument was sent to 250 members of the Pennsylvania Association of Sustainable Agriculture (PASA) and 250 members of Woodland Owner Associations (WOA). Current management objectives and production strategies, agroforestry awareness, agroforestry interest, and perceptions regarding the benefits and obstacles to agroforestry adoption were gauged. Market segmentation was performed with a two-step cluster analysis to produce four agroforestry adoption potential models: Timber-Related Practices, Livestock-Related Practices, Specialty Crop-Related Practices, and Non-Adopters. The analyses showed that agroforestry practices could satisfy specific land management objectives within diverse populations. The method effectively identified similarities in agroforestry adoption scenarios. Market segmentation could be utilised as a social marketing tool to guide future policy development, scientific research, and the efficacy and relevance of future agroforestry research and outreach programs. The next step in program development should include the creation of a statewide multidisciplinary team comprised of university, non-profit association and landowner representation, to develop agroforestry applications relevant to each cluster and promote the practices through landowner-led on-farm demonstrations and workshops.

**Keywords:** extension education programming, social marketing, woodland owner associations, Pennsylvania Association for Sustainable Agriculture, participatory education methods, needs assessments

## INTRODUCTION

Understanding landowner attitudes and interests towards an innovation is a critical first step in the process of developing a successful extension program (Association for Temperate Agroforestry 2000). Beginning in the 1960s, the agroforestry scientific community made great strides in developing multi-cropping systems that could offer solutions to issues with soil productivity, environmental remediation, product diversification, water quality problems and gender equality (Nair 1996, Garrity 2004). Unfortunately, many efforts to apply these agroforestry systems at the farmer level were not successful, resulting in low adoption or project abandonment (Mercer 2004). In response to a perceived disconnect between the scientific and potential adopter communities, socioeconomic and agroforestry adoption became more common (Garrett 1995, Williams *et al.* 1997, Franzel and Scherr 2002, Avalapati *et al.* 2004). Inadequate involvement of landowners in project development and planning has often been stated as a key factor of why agroforestry projects do not meet success during implementation (Mercer 2004).

Agroforestry must involve farmers and other landowners, more so than traditional agricultural innovations, because agroforestry involves the integration of two or more crops, creating complex planting, management and harvesting regimes, demanding additional intellectual investment and innovation skills on the part of landowners (Mercer 2004). Participatory appraisal and research methods are increasingly used to identify landowner needs, problems and concerns (Goering *et al.* 1993) in order to guide program development. The results can then be incorporated into the design of relevant, population-specific outreach and development programs (Thompson 2001). Comprehensive needs assessments are the first step in a participatory farmer development process. Needs assessments are utilised to gather information on landowner characteristics and perceptions that determine agroforestry adoption, usually categorised as: (1) household preferences, (2) resource endowments, (3) market incentives, (4) biophysical factors and (5) perceptions of risk and uncertainty (Mercer and Pattanayak 2003).

In previous agroforestry adoption studies, it was generally noted that adopting farmers shared similar socio-economic characteristics, livelihood strategies, or perceptions toward the practice (Hardesty and Lawrence 1995, Ayuk 1997, Adesina *et al.* 2000, Degrande 2001, Fischer and Vasseur 2002, Franzel and Scherr 2002). Individual factors that influenced attitudes regarding an innovation and subsequent adoption included household preferences, resource endowments, market incentives, biophysical features and risk and uncertainty, as well as perceptions of the biophysical performance, profitability, and acceptability and feasibility of the practice (Chaves and Riley 2001, Franzel *et al.* 2001).

This paper reports the application of a social marketing framework to assess agroforestry adoption potential, perceived benefits and obstacles to the adoption of agroforestry, as well as the educational support needed for the development of an agroforestry extension program in the commonwealth of Pennsylvania. The paper begins with a rationale for the use of market segmentation, sampling methodologies, and gives an overview of results of the agroforestry adoption market segmentation. Finally, policy and education suggestions are made based on results of this study.

## SOCIAL MARKETING RESEARCH TOOLS FOR PROGRAM DEVELOPMENT: MARKET SEGMENTATION

Social marketing research identifies perceptions of the barriers and benefits necessary to change behaviour among individuals and then incorporates this information in program design (McKenzie-Mohr and Smith 1999). Social marketing research draws from marketing and social science research methods (e.g. surveys, interviews and focus groups) to gather socioeconomic and perception information, and social psychology theory to develop outreach and development programs that will be relative and effective for stakeholders (Weinstein 1987, McKenzie-Mohr and Smith 1999).

Market segmentation uses multivariate regressions techniques, such as cluster analysis, to identify cases with similar patterns in responses, i.e. homogenous groups from within a heterogeneous population (Silver 1995). These groups form a consumer model. To develop the models, marketers classify consumers according to a set of demographic or geographic variables (e.g. age, race, education and location), perception and behaviour, variables (attitudes, lifestyle, values, risk aversion), and decision-making patterns (Wedel and Kamakura 2000). These consumer-modelling techniques are not only able to forecast marketplace acceptance of products and services; they can also be powerful tools for convincing institutions to support a product (Weinstein 1987, Cravens 1997). For example, donors might be more likely to invest in an alley cropping demonstration project if it is shown that a known proportion of the landowner population (a segment) would adopt the practice if they had access to working demonstrations. The donor institution could estimate the return on their investment in installing and providing access to alley cropping demonstration sites (number of adopters). In Australia, Kaine and Niall (1999) used in-depth personal interviews and a mail survey to segment Australian dairy farmers according to soil drainage problems. Results of the study were used to create two separate extension strategies for farmer segments based on their needs for wet soils management.

In applying market segmentation terminology to agroforestry adoption potential, it is feasible to consider the land grant institution interested in agroforestry outreach as the business, and landowners as consumers who would potentially adopt some type of agroforestry practice. Though landowners may integrate more than one practice to accomplish a specific objective, it is not likely that they are going to adopt them all. With this outlook, agroforestry can comprise an entire line of possible products (Kaine and Niall 1999). Ultimately, segmentation allows one to narrow the scope of a marketing scheme by combining variables into a homogenised component and creating targeted, more effective outreach programs (Crimp 1981).

## CASE STUDY AREA

Family farms and timber operations have contributed substantially to Pennsylvania's rural economy since the early 1900s (Pennsylvania Department of Community and Economic Development 2003). Beginning in the 1950s, these family operations began to experience increasing challenges to economic sustainability, attributed to competition from a steady consolidation of agricultural industry (Goering *et al.*

1993). Perceived threats due to increased economic globalisation and environmental degradation has spurred the creation of many institutions and associations, some that focus on retaining rural and traditional community structure, others on curbing economic loss of agriculture and forestry (Keystone Agricultural Innovation Institute, Association for Rural Pennsylvania), and still others that focus on ameliorating negative environmental changes, including air and water pollution, soil erosion, and land use changes (Penn Environment) associated with loss of open space (Thompson 2001, Jackson 2002, Pennsylvania Department of Agriculture 2003). There is potential for many of these stakeholders to utilise one or more agroforestry practices as a tool in their development or conservation objectives.

## RESEARCH METHOD

There are currently more than 500,000 landowners in Pennsylvania (Pennsylvania Department of Community and Economic Development 2003). Members of the Pennsylvania Association of Sustainable Agriculture (PASA) and Woodland Owner Associations (WOA) were chosen as the target population because their self-selecting membership in such organisations displayed an interest in improving land use, and because they had a greater chance of having had an initial exposure to agroforestry.

### Developing and Testing the Mail Survey Instrument

Approaches described by Dillman's Total Design Method (2000) and The Complete Survey Kit (Fink 1995) were used to guide the design and administration of a mail survey instrument. The survey mailing included a cover letter, the survey instrument, and a stamped return envelope. The survey instrument was designed to gather information regarding:

1. Socioeconomic and demographic characteristics;
2. Land management and production characteristics;
3. Agroforestry adoption potential; and
4. Perceived barriers and obstacles regarding agroforestry adoption.

A literature review, personal communications and results of a focus group discussion were used to facilitate survey question design. The majority of questions used a Likert scale to indicate the degree to which participants placed importance on statements. Importance rating ranged from 1 to 5 where 1 was the least important, and 5 indicated a very important rating. To establish content validity and clarity, the survey instrument was tested in a graduate-level survey research course, as well as with landowners who were attending extension workshops on non-timber forest products.

### Sampling Procedure

A stratified, proportional random sampling procedure was used to select 250 participants each from the 1200 PASA members (Pennsylvania Association for Sustainable Agriculture 2003) and from 869 WOA members (Harmon 2003). Although there were PASA members in every county in Pennsylvania, only PASA members in counties that

also had WOA were sampled. Figure 1 illustrates the number of questionnaires sent to PASA members and Figure 2 the number sent to WOA members in each represented county.

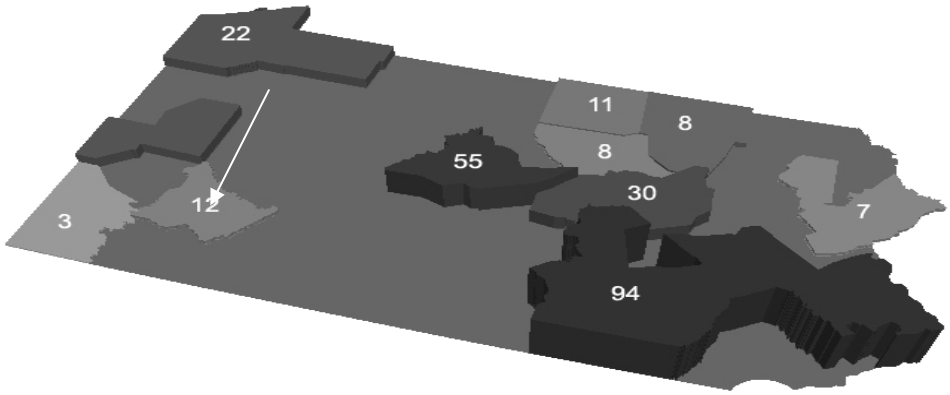



**Figure 1.** Number of PASA members sampled within county blocks of Pennsylvania

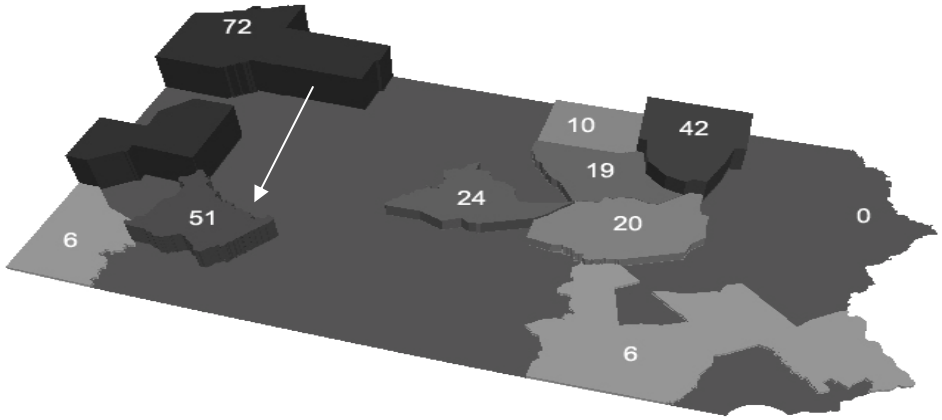



**Figure 2.** Number of WOA members sampled within county blocks of Pennsylvania[1]

## ANALYSIS OF SURVEY DATA

Descriptive statistics including frequencies, averages and percentages were used to describe mail survey respondent characteristics. Responses to open-ended questions and any additional comments were grouped by important themes and recorded in a

[1] Participating WOAs included Bradford-Sullivan Forest Landowners Assoc., Butler Co. WOA, Central Susquehanna WOA, Lycoming Co WOA, Southeast Forest Resources Assoc., Tioga WOA, Westmoreland Woodland Improvement Assoc., Woodland Owners of Centre Co. and Washington/Greene C. WOA.

separate document. Factor analysis (Stevens 2002) was used to measure covariance and to group related variables. A two-step, hierarchical cluster analysis (following McGarigal *et al.* 2000) was used to perform the market segmentation, and to identify correlations between factored variables among respondents (Stevens 2002). Cluster analysis uses classification algorithms to classify data into meaningful structures, or taxonomies (McGarigal *et al.* 2000) and is commonly applied in market segmentation research (Silver 1995). This statistical tool allows the researcher to specify the number of clusters (K), or allow the program to select the number of clusters, and the algorithm will proceed to divide the data into K clusters. The means and centroids are calculated. If the distance from any given case, or variable, to the centroid of another cluster is closer, then the case will be put in the other cluster (Weinstein, 1987). SPSS computer software performs hierarchical clustering, non-hierarchical K-means clustering, and two-step cluster analysis (Green and Salkind 2003). Two-step cluster analysis was used because of the tool's ability to discern categorical from continuous data (Green and Salkind 2003).

Responses to the question 'Which agroforestry practice are you most likely to adopt?' were used as a dependent variable for the two-step cluster analysis. Independent variables included the following factored variables: Current production, Reasons for owning land, Issues in land management, Knowledge of agroforestry, Perceived benefits and Perceived obstacles to agroforestry adoption. Also included were demographic and socioeconomic variables (age, income, occupation, education, family size, gender, PASA or WOA affiliation), as well as variables regarding land size, tenure and land types (field, pasture, forest, fallow, orchard and wetland).

## SURVEY FINDINGS

Of the 500 questionnaires mailed, 274 were returned, (54.8% gross return rate), and 223 were usable, resulting in a 44.6% usable response rate. Of the 51 questionnaires that were not usable, 27 were returned blank, and the rest had explanations written in, including: (1) they had joined the association to support it, but were not currently practicing forestry or agriculture, (2) they were interested in agroforestry but felt they did not currently have enough time to invest in new practices, (3) they worked for a non-profit or governmental association related to natural resources or farming. Spouses of deceased association members returned five questionnaires. Non-respondents were not contacted as per agreement with PASA and WOA.

### Market Segmentation: Agroforestry Adoption Potential

The two-step cluster analysis produced four distinct customer models that describe agroforestry adoption potential scenarios. These clusters were identified and named according to the dominant crop that the agroforestry practices of interest would benefit. These clusters were classified as (1) Timber-related agroforestry practices, (2) Livestock-related agroforestry practices, (3) Specialty crop-related agroforestry practices, and (4) Non-adopters. Figure 3 shows the four classified agroforestry adoption clusters in terms of their percentage of total participants as well as within-cluster percentages of agroforestry practices selected. Within-cluster percentages and means for each dependent variable are provided in Tables 1 and 2, which are

used to characterise each cluster, as well as to assess the similarities and differences between each agroforestry adoption cluster.

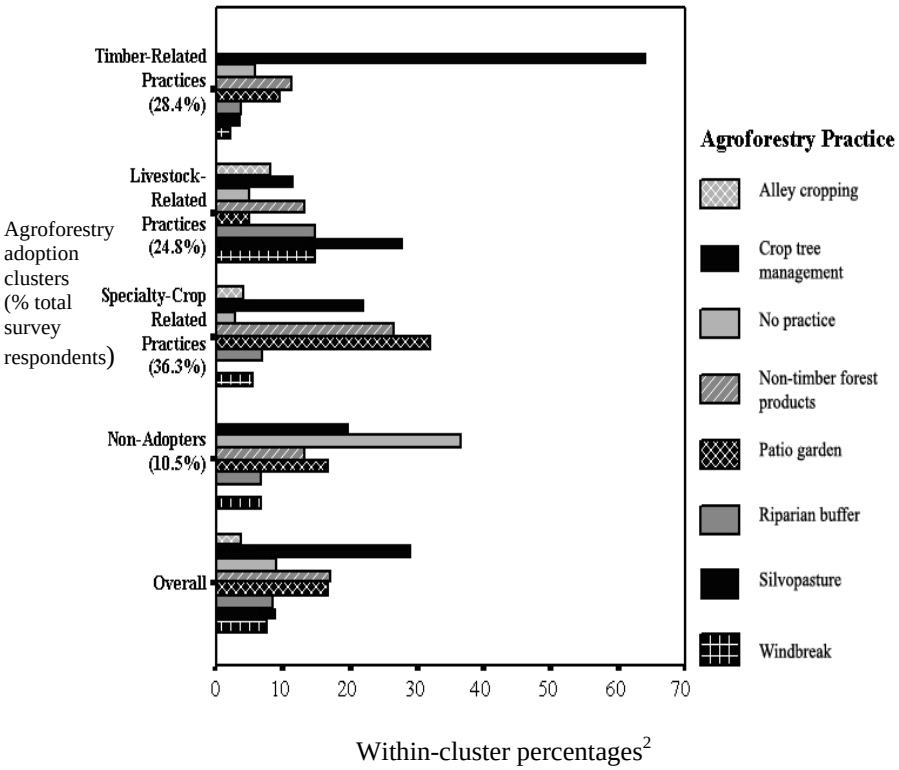



**Figure 3.** Agroforestry adoption potential consumer models

Overall, a large majority (90%) of respondents were interested in some type of agroforestry practice or combination of practices. Approximately 29% of the participants were interested in agroforestry practices that complemented timber-related land management (crop-tree management, non-timber forest products), and about a quarter were interested in practices that would enhance livestock production (silvopasture, windbreaks, riparian buffers). More than one third (36.3%) of the respondents were interested in specialty crop production, producing non-timber forest products through forest farming, and only 10% were not interested in agroforestry adoption in any capacity

**Socioeconomic Characteristics of Adoption Clusters**

Adopters in each cluster had differing socioeconomic characteristics (Table 1). All of the clusters contained members of both PASA and WOA associations, though some were more dominant in particular clusters. As was to be expected, most of the individuals in the timber-related agroforestry practices adoption cluster were

[2] Percent within each cluster that chose a particular agroforestry practice as a response to the question, 'Which agroforestry practice are you most likely to adopt?'

members of WOA (98%) as were a majority of the non-adopters (70%). The livestock-related agroforestry practices cluster contained about 75% PASA and 25% OA members. The specialty-crop agroforestry practices cluster had a more even distribution of associations (60% PASA, 40% WOA), and had more female participants than the other clusters, which were predominately male. Non-adopters were generally older participants, whereas the livestock and specialty-crop clusters were characterised by younger (40-59) participants. The timber-related cluster had large proportions of both younger and older members. More timber-related practices members considered themselves retired, and only the livestock-related practices cluster had a large number of respondents who considered themselves farmers. Most respondents in all clusters owned less than 40 hectares (ha), with a majority of the specialty-crop related practices cluster owning less than 5 ha.

**Table 1.** Within-cluster percentages for demographic variables

| Demographic variable | Timber-related practices (%) | Livestock-related practices (%) | Specialty-crop practices (%) | Non-adopters (%) |
|---|---|---|---|---|
| Association | | | | |
| PASA | 2 | 75 | 60 | 30 |
| WOA | 98 | 25 | 40 | 70 |
| Gender | | | | |
| Male | 90 | 90 | 60 | 70 |
| Female | 10 | 10 | 40 | 30 |
| Age | | | | |
| 18-39 | 10 | 20 | 21 | 2 |
| 40-59 | 40 | 66 | 65 | 19 |
| 60-69 | 15 | 10 | 12 | 34 |
| 70+ | 35 | 4 | 2 | 45 |
| Occupation | | | | |
| Farmer | 10 | 56 | 5 | 8 |
| Retired | 39 | 1 | 18 | 81 |
| White collar | 31 | 38 | 37 | 3 |
| Blue collar | 15 | 3 | 15 | 2 |
| Other | 5 | 2 | 25 | 6 |
| Area (ha) | | | | |
| 1- 4 | 55 | 24 | 75 | 1 |
| 5 – 20 | 17 | 35 | 15 | 20 |
| 21 – 40 | 28 | 36 | 9 | 60 |
| 41 – 200 | 0 | 5 | 1 | 18 |
| 201+ | 10 | 0 | 0 | 1 |

**Table 2.** Within-cluster means for current production, issues regarding land management, benefits, and obstacles to agroforestry adoption

| Variable | Adoption potential cluster | | | |
|---|---|---|---|---|
| | Timber-related practices | Livestock-related practices | Specialty-crop practices | Non-adopters |
| Current production (on a scale of 1-3)[a] | | | | |
| 1. Forestry and hunting | 2.2 | 1.8 | 1.5 | 1.5 |
| 2. Livestock | 1.3 | 2.4 | 1.2 | 1.3 |
| 3. Veg/Fruit/NTFP | 1.1 | 1.5 | 1.5 | 1.2 |
| Reasons for owning land (on a scale of 1-5)[b] | | | | |
| 1. Quality of life | 3.9 | 4.2 | 4.4 | 3.3 |
| 2. Forestry and hunting | 3.8 | 2.9 | 3.2 | 2.5 |
| 3. Traditions and farming | 2.8 | 3.9 | 2.4 | 1.7 |
| 4. Real estate investment | 3.1 | 2.9 | 3.1 | 2.4 |
| Issues in land management (on a scale of 1-5)[b] | | | | |
| 1. Agric. production and marketing | 2.6 | 3.7 | 2.8 | 1.7 |
| 2. Land-use changes | 3.8 | 4.3 | 4.1 | 3.0 |
| 3. Forestry | 4.1 | 3.4 | 3.5 | 3.1 |
| Benefits to adoption (on a scale of 1-5)[b] | | | | |
| 1. Environmental | 3.2 | 4.1 | 4.3 | 2.7 |
| 2. Economic | 2.5 | 3.8 | 3.5 | 1.3 |
| 3. Production | 2.6 | 3.9 | 3.5 | 1.3 |
| Obstacles (on a scale of 1-5)[b] | | | | |
| 1. Access to information | 2.6 | 3.0 | 3.0 | < 1 |
| 2. Profitability | 2.9 | 3.2 | 3.2 | < 1 |
| 3. Feasibility | 2.5 | 3.1 | 2.9 | < 1 |

a. 1 = never produced to 3 = currently producing, b. 1 = not at all important to 5 = very important.

**Land Management Characteristics**

Participants in the four clusters had different current production practices, reasons for owning land, and concerns in regards to land management (Table 2). For example, the livestock-related agroforestry practices cluster was interested in practices that would assist in sustaining economic and productive viability of existing farms, and their primary concerns were threats to livelihood due to land-use changes and agricultural marketing trends. Although the specialty-crop cluster was interested in the production and marketing of specialty crops for profit, potential adopters from this cluster were more interested in quality of life variables, such as

'providing healthy food for my family', as well as environmental variables, such as 'improving wildlife habitat'.

**Benefits and Obstacles to Agroforestry**

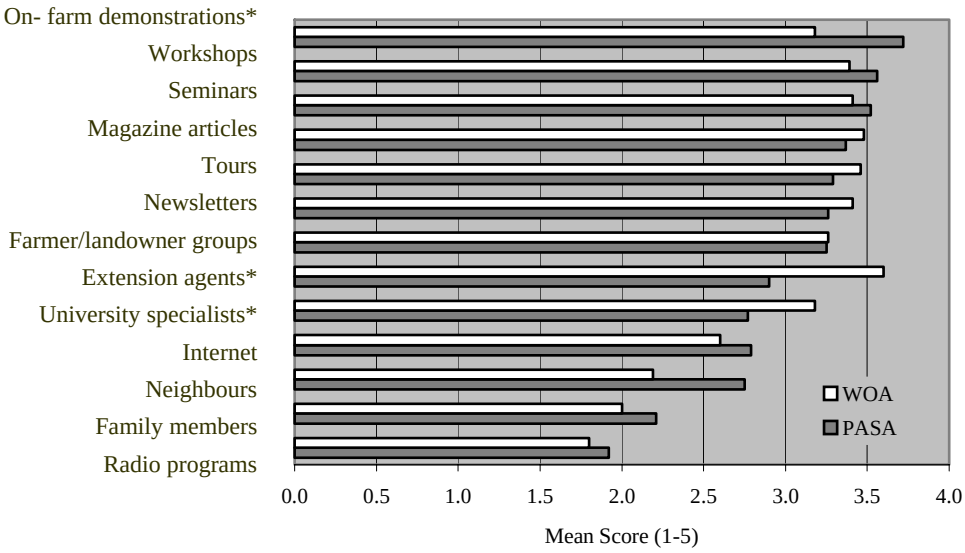
Overall, the agroforestry adoption clusters considered environmental benefits (improves water quality, protects soil, improves wildlife habitat) as the most important benefits to adoption (Table 2). This was expected because participants for this study had taken the effort to be part of associations concerned with land-use and environmental concerns. It may also be that potential adopters in the timber-related and specialty crop related agroforestry clusters did not see the potential for agroforestry to be profitable and therefore did not assign those benefits high scores. Only potential adopters in the livestock-related cluster, who derived more of their income directly from agricultural production, considered the economic and production-related benefits as highly important.

Economic obstacles in particular received high scores, including the obstacles 'Cannot afford to experiment', 'Expense of additional management', and 'Do not know where to market products'. It may be argued, however, that these are really issues related to a lack of access to information, as landowners state that they were unclear as to where they could market their products, but did not think that agroforestry products themselves were unprofitable. Many of the concerns regarding management logistics and market access could be resolved with extension activities that provided exposure to demonstration sites, marketing information and technical assistance.

**Preferences for Learning about Agroforestry**

Educational preferences were not utilised in the factor or cluster analysis, because the differences between variables were not sufficient to warrant factoring in Mann-Whitney U tests for significant differences. Figure 4 shows the importance of several educational methods as perceived by survey respondents.

The differences to note with regard to educational preferences were that WOA members found extension agents and university specialists to be significantly more useful (at the 5% level) as means to learn about agroforestry than PASA members, and that demonstration tours were considered significantly (at the 5% level) more useful for learning about agroforestry than WOA members. The internet received a low rating for usefulness as an educational tool. This is a significant insight at a time when many extension programs around the world are developing on-line programs and suggests that although distance education can be a useful mechanism for raising the awareness of new technologies to many land managers, it should not completely supplant hands-on activities as means for land managers to be able to critically analyse and gain confidence in applying technologies.




[1] = not at all useful, through to 5 = very useful, * indicates the 5% significance level.

**Figure 4.** Usefulness of educational materials and dissemination methods

## CONCLUSIONS

The results of this study support the hypothesis that there is an opportunity and need to develop a strategic agroforestry extension program in Pennsylvania. Though members of the separate clusters were interested in unique practices, and had different objectives for being interested in agroforestry, the majority were interested in the idea of incorporating some form of multi-cropping system as a complementary practice to their current production and as an additional income source. As one Christmas tree operator from a focus group in Bucks County stated, *'This* (agroforestry) *is just a start in the movement to help farmers actually make a living from farming'*.

Although interested, most of the participants did not feel they currently had enough information regarding implementation, management and marketing in order to adopt agroforestry. Based on this needs assessment, the Pennsylvania State University extension program can begin to engage a multidisciplinary group of stakeholders to build a collaborative agroforestry team. With diverse sets of expertise and experience, the team would be able to develop agroforestry applications and programs that appeal to each of the three adoption clusters. Included in this team should be forestry, livestock and horticultural specialists, as well as extension personnel and representative landowners. Several survey participants stated that they were already practicing agroforestry on their properties, or would like to but could not afford to experiment. These individuals could be contacted and visited to generate case studies. A mini-grant could be made available for those wishing to trial an agroforestry practice on their land. In return, landowners could share their

experiences and innovations with other similar producers through landowner tours and published case studies. Regular assessments would ensure that programs continue to meet landowner needs and track evolution of opportunities and barriers to agroforestry adoption (Chambers 1997).

Almost all participants agreed that they needed to see the practices on the ground before they would contemplate adoption. Just as producers are looking for means to incorporate agroforestry in existing land practices, so an agroforestry extension program could be incorporated into existing outreach mechanisms. For example, PASA has highly successful on-farm education and research programs through which agroforestry outreach programs could be conducted to raise agroforestry awareness, showcase agroforestry applications and explore marketing opportunities.

Agroforestry has the potential to reach a diverse set of Pennsylvania landowners with differing needs and objectives. Approximately 90% of survey participants stated that they would consider adopting agroforestry if information was made available, if they could see working demonstrations of agroforestry, and if they could receive some form of technical assistance. Additionally, market segmentation showed that 30% of these individuals will be WOA members interested in crop-tree management and non-timber forest products, that a quarter of those will be livestock farmers in both WOA and PASA who are interested in silvopastoral options on their land, and that almost 40% of those will be women and men in both associations interested in incorporated multi-cropping systems to their specialty vegetable and fruit production. Market segmentation narrowed a broad and general set of possibilities to three targeted objectives that could be used to establish agroforestry program goals, and could be applied to perform needs assessments and set target objectives for other program development initiatives.

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